

STATUS OF MULTI-BEAM LONG TRACE-PROFILER DEVELOPMENT

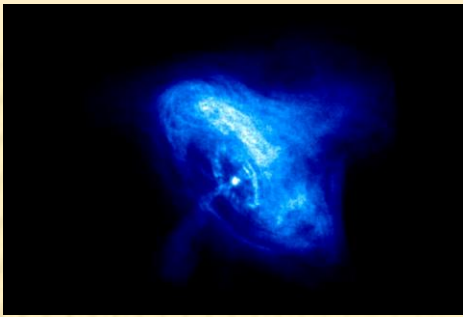
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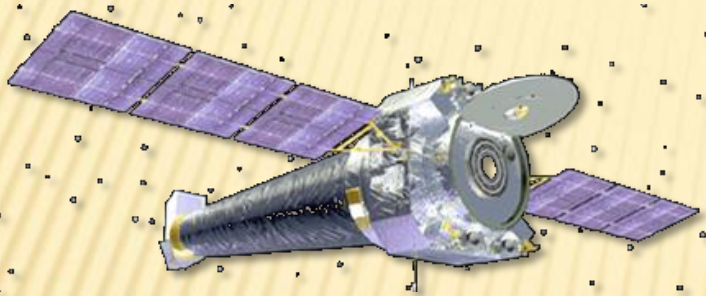
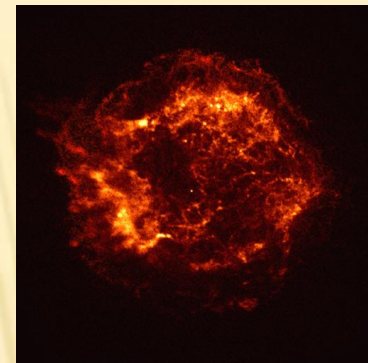
²Lawrence Berkeley National Laboratory

³Brookhaven National Laboratory

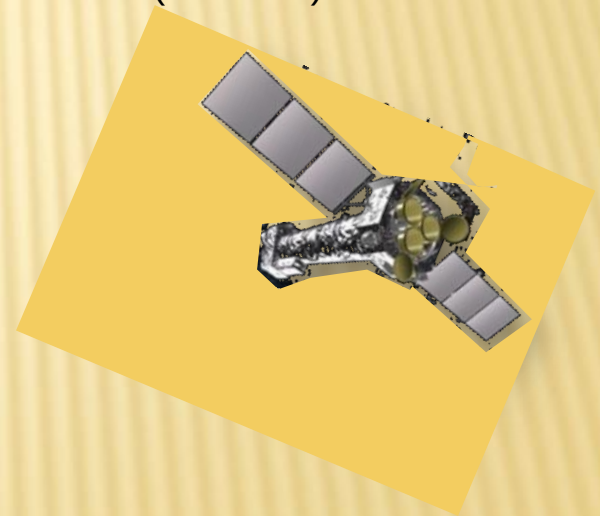
⁴Texas A&M University-Commerce



Future Challenge for metrology of x-ray optics for astrophysical applications



XMM-Newton (1999-?)
HPD = 14", $A = 0.43 \text{ m}^2$ ($f = 7.5 \text{ m}$)



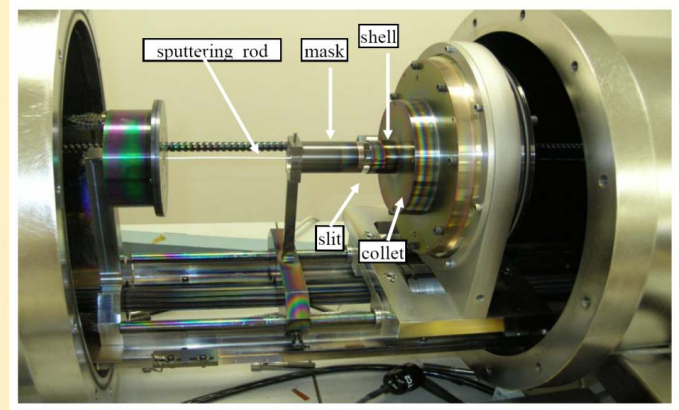
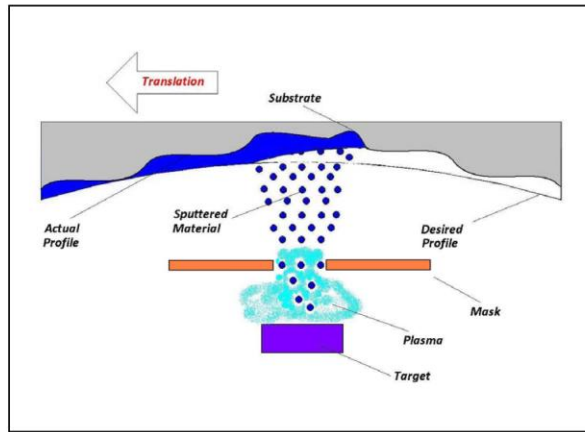
Chandra X-ray Observatory (1999-?)
HPD = 0.6", $A = 0.11 \text{ m}^2$ ($f = 10 \text{ m}$)

Need for large ($\sim 1 \text{ m}^2$) effective area, sub-arcsecond x-ray optics

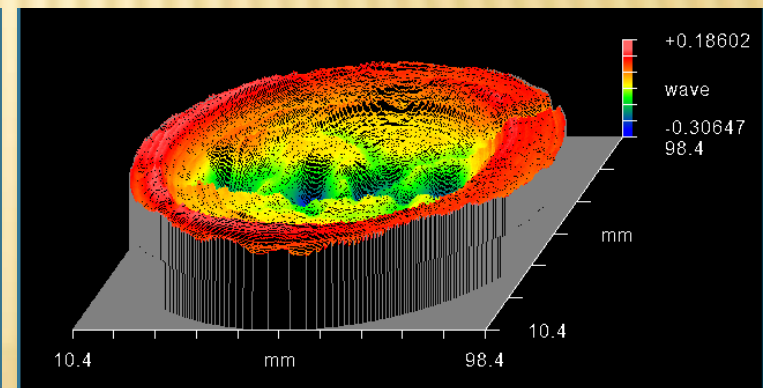
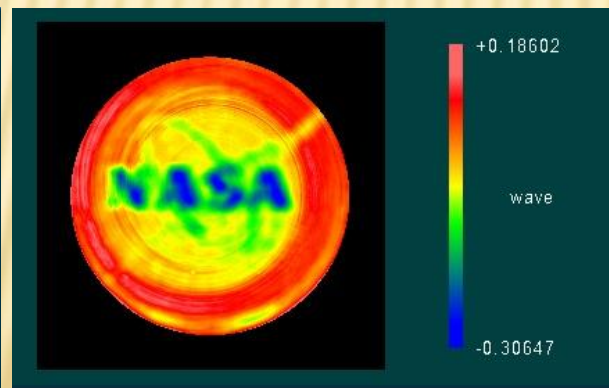
Has to be light-weighted

Possible approaches to achieve the goal (MSFC)

Very thin optics (200-300 micron thick) - Differential deposition

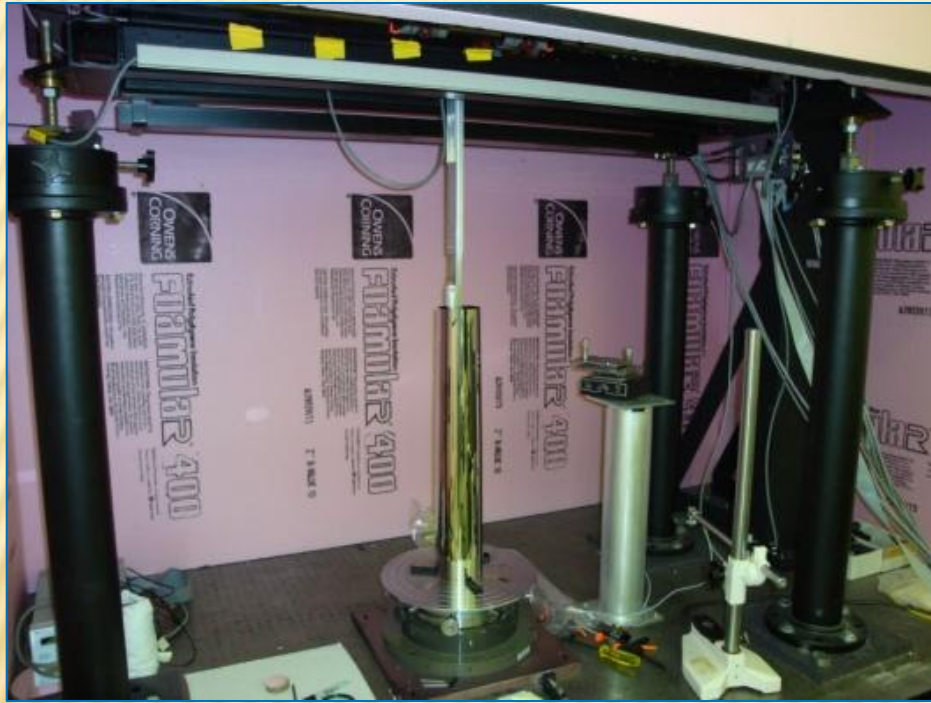


Relatively thick optics (2-3 mm thick) – Deterministic polishing



Fast figure metrology with sub microradian resolution

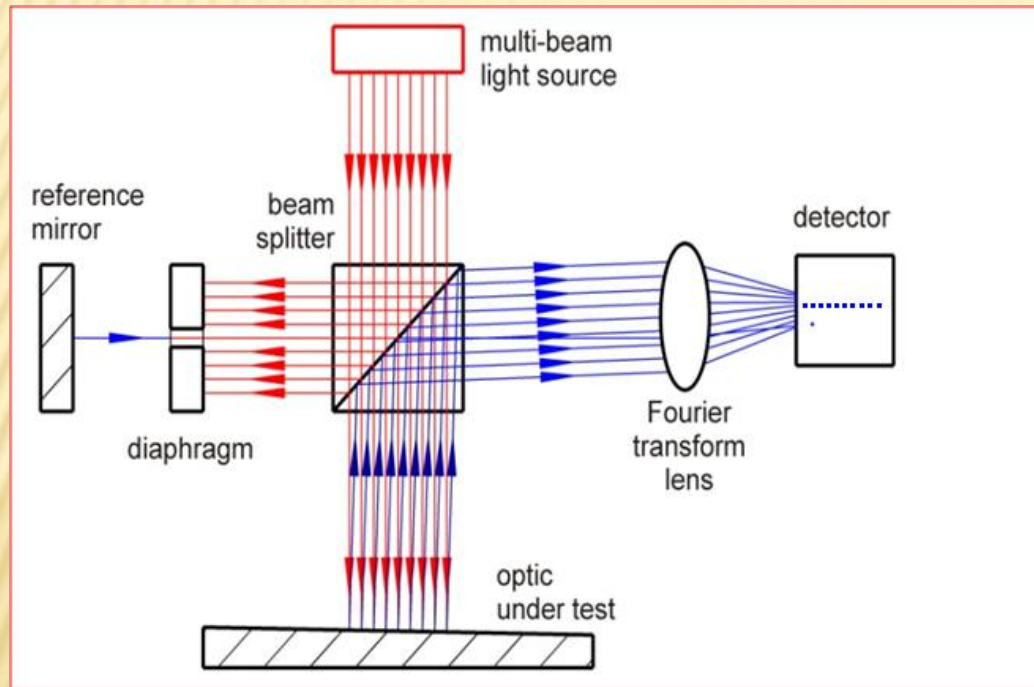
Long Trace Profiler



☹ Time taken to measure is about 5 mins for 300 mm sample length

- Pencil beam interferometry
- Measure spatial wavelengths starting from 1 mm upto several 100's of mm
- Laser beam scans point-by-point - slope data
- Position of the beam at the detector - direct measure of the slope
- Accuracies possible < 1 urad
- Multiple measurements - 2D topography

Multi-beam long trace-profiler



Schematic of the MBLTP

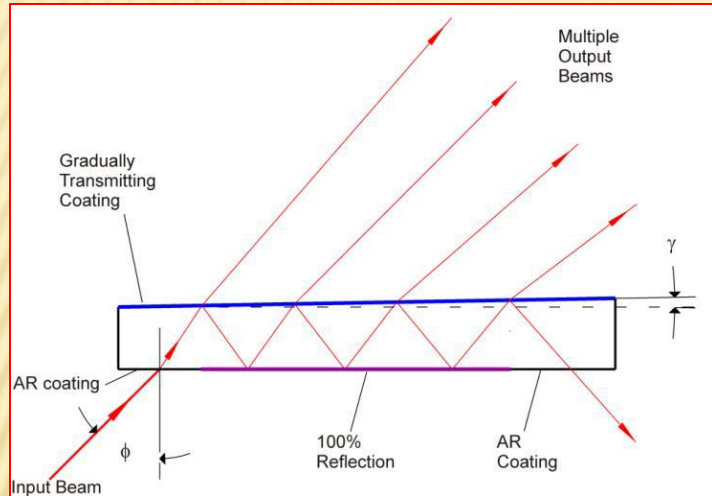
Further improvements:

- Make use of advanced technology
- Higher resolution and faster 2D detectors
- Stable optical sources
- Increase the speed & accuracies of measurements -

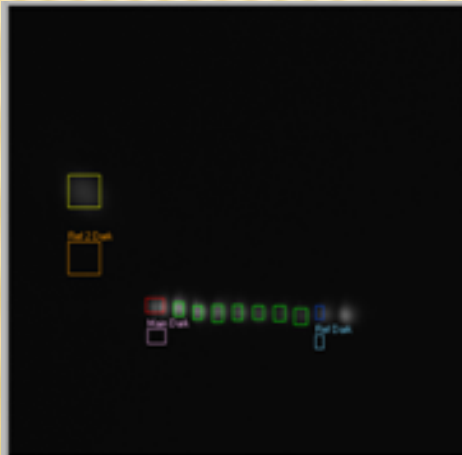
Multiple beams

Internal funding, so approach is to order off-shelf optics for proof-of-concept. Then, select the best and define the goals for optical elements quality improvements

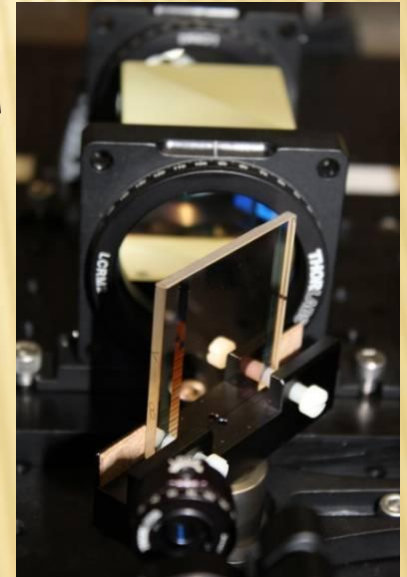
Multibeam LTP - Design



Etalon Schematic

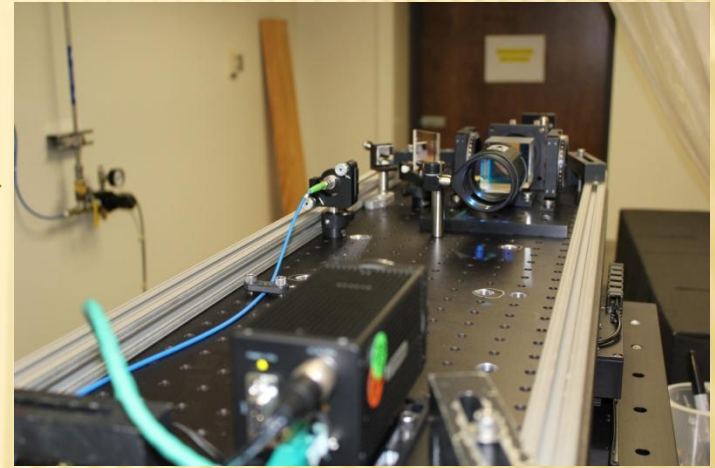
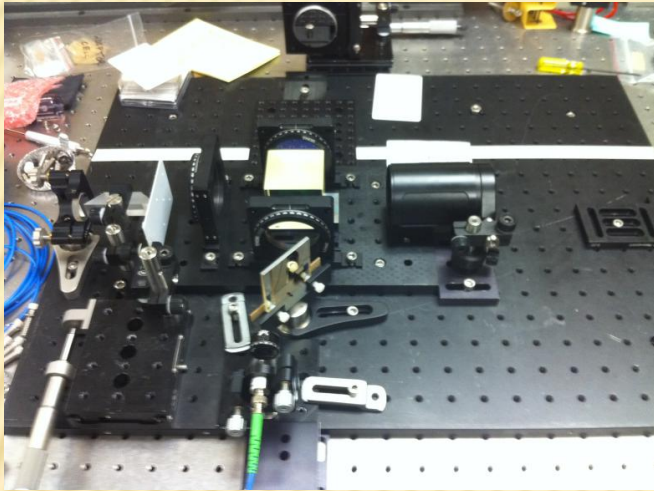


- Number of beams -10; almost equal intensity
- Spatial and angular separation of beams - 2.4 mm and 200 μrad
- Dimension - 50 x 50 x 3 mm
- Wedge - 60 μrad
- Silver coating design



- Detector -36 mm x 24 mm area, 7.4 x 7.4 μm pixel size, 1.3 fps for partial frame of 4872x800
- Custom designed FT lens - air-spaced doublet lens, 500 mm focal length, 50 mm diameter.
- The system resolution due to the detector-lens pair is estimated to be ~ 0.23 microrad.
- Berkeley National Labs has provided software code, we have adapted it for new detector and to track ten beams

MODIFICATIONS

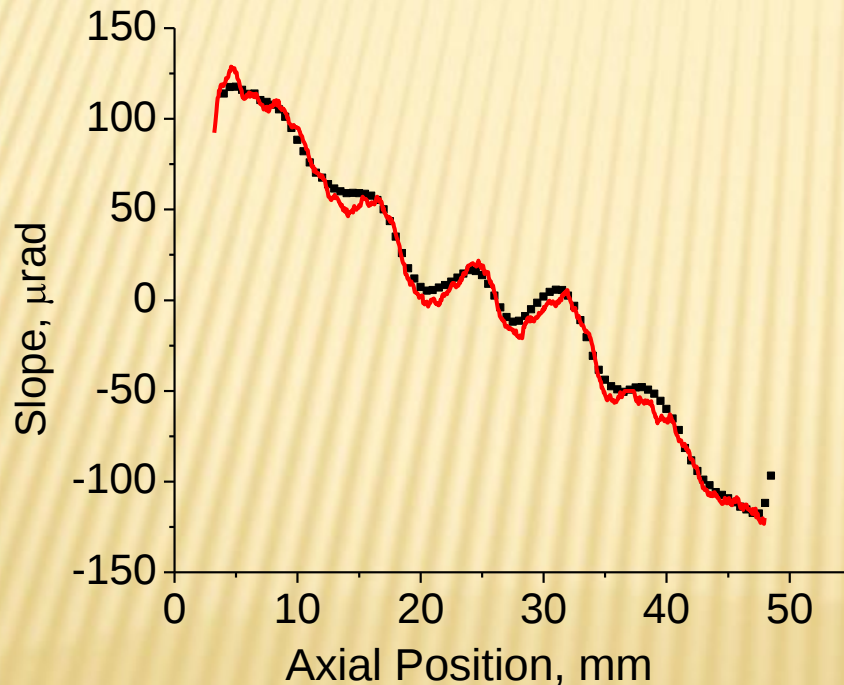


- ✓ Reconfigured the optical board – to have a “small” footprint
- ✓ Integrated the air bearing stage, the height is adopted for the 0.5 m diameter x-ray mirror shells
- ✓ Modified the existing software to control the stage



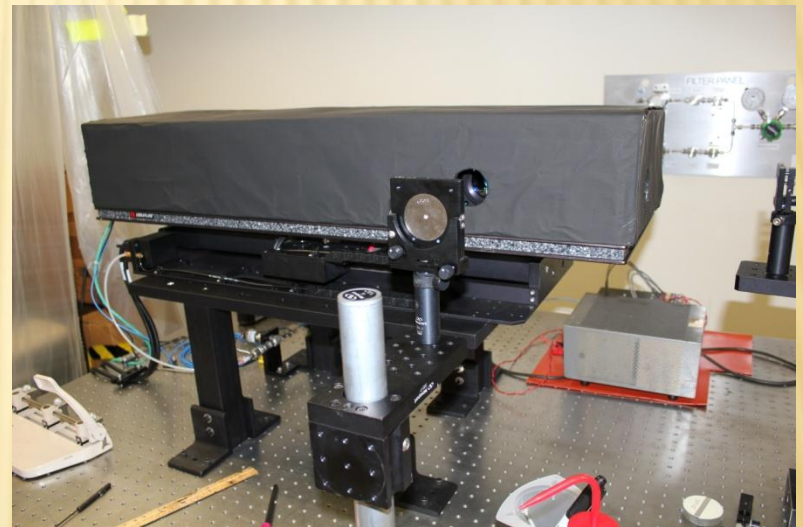
First Slope Measurements

- ❖ Translation by 1 mm
- ❖ Ten slope profiles from the individual beams are stitched



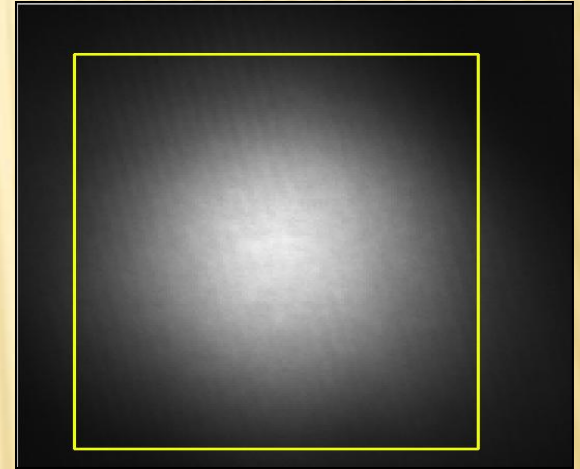
Red – Zygo interferometer, Black - MBLTP

Curved mirror



Future plans

- Incorporate the windowless detector (procured)
- Fine tuning to reduce systematic errors
- Formulate requirements for the optical elements for future improvement of the MBLTP performance



Reference beam on detector,
secondary interference fringe
pattern is due to the cover
plate on the detector

Conclusions

- ✓ A multi-beam LTP is under development at MSFC in collaboration with Lawrence Berkeley National laboratory and Brookhaven National Laboratory.
- ✓ The Multi-beam LTP has been fully assembled.
- ✓ First tests of the MBLTP has demonstrated the feasibility of the multibeam approach.
- ✓ The calibrations are under way
- ✓ The MBLTP is intended to be used for metrology support of the deterministic polishing experiments